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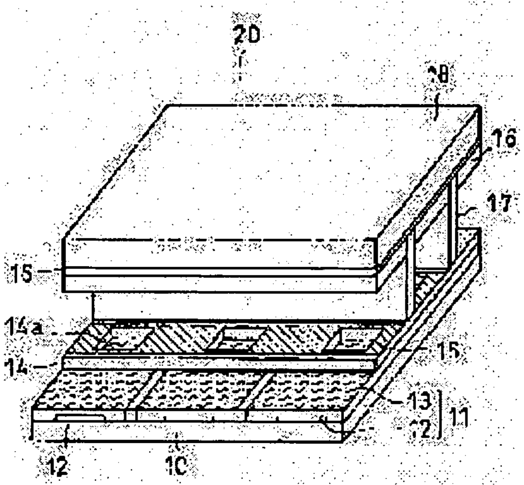
(54) COLD CATHODE ELECTRONIC DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a cold cathode electronic device (FED) capable of shortening a distance between a gate and an emitter, and remarkably reducing the driving voltage.

SOLUTION: This cold cathode electronic device uses a tantalum board 14 supporting a gate controlling the electron emitted from a cold cathode 11 having an emitter 13 toward an anode 16, and having a self-oxidized film for the insulation between the gate 15 and the emitter.



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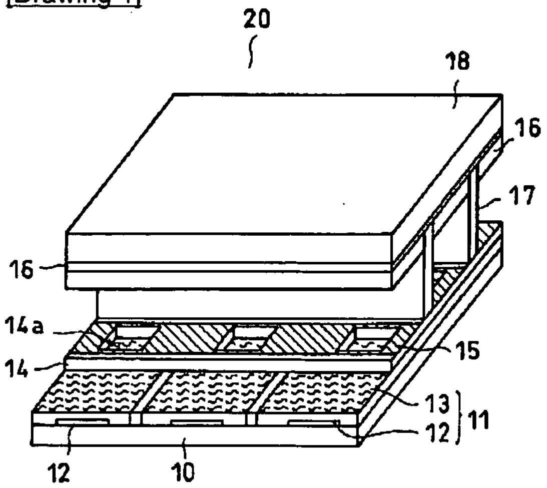
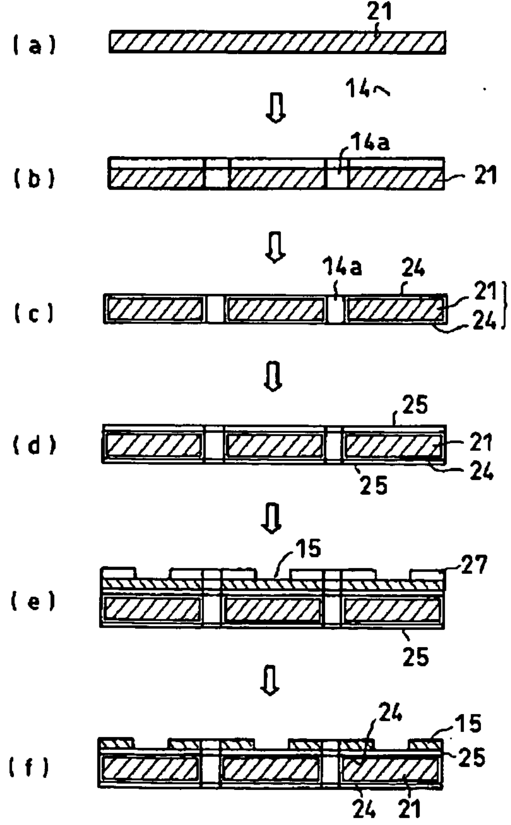
DRAWINGS

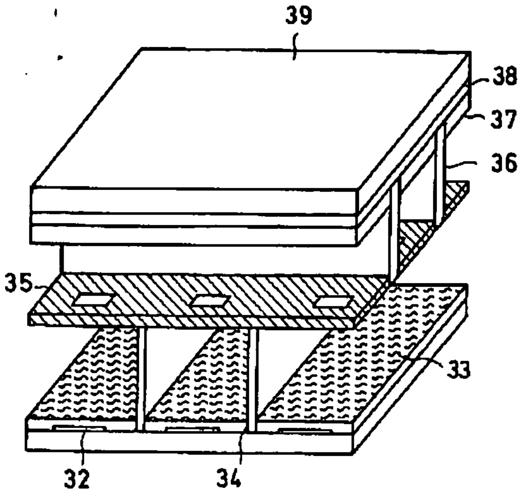
[Drawing 1]



[Drawing 2]



[Drawing 3]



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PRIOR ART

[Description of the Prior Art] Paying attention to the passing speed of the electron in a vacuum, a controllability, etc., an electron is made to emit by minute cold cathode, and development of the vacuum micro which it is going to apply to equipments, such as FED (Field Emission Display), is performed. Development of the display using a nanotube especially thin [a carbon nanotube etc.] as an electron emission object (emitter) of cold cathode and long is active (00 S. Uemura, J.Yotani et ai., SID' 320 (2000)).
[0003] The configuration of the display is shown in drawing 3 . As the nanotube as the emitter side glass substrate 31 used as an envelope, the emitter wiring 32, and an emitter 33, the first rib 34, and a control electrode, a display consists of a transparent electrode as a grid 35, the 2nd rib 36, a fluorescent substance 37, and an anode 38, an anode side glass substrate 39 used as an envelope, etc., and the interior of the emitter side glass substrate 31 and the anode side glass substrate 39 is held at the vacuum. A grid 35 consists of in the shape of Rhine, metaled foils, for example, nickel etc., etc. which carried out opening, and corresponds to each pixel Rhine, and only the number of Rhine is arranged.
[0004] Electrons are the electric field by the electrical potential difference impressed between a grid line and emitter wiring Rhine, and the fluorescent substance 37 which it is emitted from the appropriate pixel emitter 33, and an electron is attracted with the electrical potential difference impressed to the anode 38, and is in an anode 38, and fluorescence is generated.
[0005] Since it insulates with an emitter 33, a grid 35 is formed on the first glass rib 34 used as a spacer. Moreover, since an anode needs to be insulated, it makes the second rib 36 intersect perpendicularly on the first rib 34, and is arranged. However, a rib tends to break by the ability having done with glass, and in the activity stood and fixed by the frit of an adhesion bridging etc., since height of 100 micrometers or more is needed, spacing of a grid 35 and an emitter 33 is also set to 100 micrometers or more, and the drive by the high electrical potential difference is needed for acquiring electric field required for electron emission.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing 1 is the outline perspective view showing the structure of one example of this invention.
[Drawing 2] Drawing 2 is the schematic drawing showing the gate of drawing 1 , and the production process of a tantalum substrate.
[Drawing 3] Drawing 3 is the outline perspective view of the conventional structure.
[Description of Notations]
10 Emitter Side Glass Substrate,
11 Cold Cathode
12 Emitter Wiring,
13 Emitter,
14 Tantalum Substrate,
15 Gate,
16 Anode,
17 Rib,
18 Anode Side Glass Substrate,
19 Fluorescent Screen,
20 Envelope
21 Tantalum Plate,
22 Opening,
23 Resist,
24 Autooxidation Film,
25 Oxidation Silicon Film,
27 Resist

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a cold cathode electronic instrument.
[0002]
[Description of the Prior Art] Paying attention to the passing speed of the electron in a vacuum, a controllability, etc., an electron is made to emit by minute cold cathode, and development of the vacuum micro which it is going to apply to equipments, such as FED (Field Emission Display), is performed. Development of the display using a nanotube especially thin [a carbon nanotube etc.] as an electron emission object (emitter) of cold cathode and long is active (00 S. Uemura, J.Yotani et ai., SID' 320 (2000)).
[0003] The configuration of the display is shown in drawing 3 . As the nanotube as the emitter side glass substrate 31 used as an envelope, the emitter wiring 32, and an emitter 33, the first rib 34, and a control electrode, a display consists of a transparent electrode as a grid 35, the 2nd rib 36, a fluorescent substance 37, and an anode 38, an anode side glass substrate 39 used as an envelope, etc., and the interior of the emitter side glass substrate 31 and the anode side glass substrate 39 is held at the vacuum. A grid 35 consists of in the shape of Rhine, metaled foils, for example, nickel etc., etc. which carried out opening, and corresponds to each pixel Rhine, and only the number of Rhine is arranged.
[0004] Electrons are the electric field by the electrical potential difference impressed between a grid line and emitter wiring Rhine, and the fluorescent substance 37 which it is emitted from the appropriate pixel emitter 33, and an electron is attracted with the electrical potential difference impressed to the anode 38, and is in an anode 38, and fluorescence is generated.
[0005] Since it insulates with an emitter 33, a grid 35 is formed on the first glass rib 34 used as a spacer. Moreover, since an anode needs to be insulated, it makes the second rib 36 intersect perpendicularly on the first rib 34, and is arranged. However, a rib tends to break by the ability having done with glass, and in the activity stood and fixed by the frit of an adhesion bridging etc., since height of 100 micrometers or more is needed, spacing of a grid 35 and an emitter 33 is also set to 100 micrometers or more, and the drive by the high electrical potential difference is needed for acquiring electric field required for electron emission.
[0006]
[Problem(s) to be Solved by the Invention] By narrowing spacing of a control electrode and an emitter, this invention reduces driver voltage and aims at offering a highly efficient cold cathode electronic instrument.
[0007]
[Means for Solving the Problem] In view of a pre-technical problem, this invention uses the sheet metal of a tantalum for the support substrate of a control electrode. That is, in the cold-cathode electronic instrument possessing the control electrode which is arranged in a vacuum envelope and this envelope, is prepared between the cold cathode which emits an electron, the anode which counters this cold cathode and is prepared, and said cold cathode and anode, and controls said electron, it is the cold-cathode electronic instrument characterized by coming to support said control electrode with the tantalum substrate which consists of a tantalum plate covered by the autooxidation film.
[0008] A substrate is insulation, becomes a spacer holding spacing of cold cathode and a control electrode, and secures narrow spacing to a precision. A tantalum plate has flexibility enough in a substrate with thin range extent of 5 micrometers thru/or 50-micrometer thickness. There is no destruction in handling etc. and its coefficient of linear expansion is close to the coefficient of linear expansion of 6.5x10-6 [**-1], glass, etc., By there being glass, concordance, and a cone property and forming thickness (1 micrometer thru/or 10 micrometers) of Ta oxide film in a tantalum plate by autooxidation etc. further By leaving without adhesion is high, and a high insulating insulator layer can form on a tantalum plate and oxidizing a tantalum plate completely showed that a substrate with the flexibility of a tantalum was obtained in the whole substrate. The tantalum autooxidation film can be easily formed by steam oxidation of 500 degrees C or more etc.
[0009] Since it curves, so that the thickness of sheet metal becomes thin, and the effect of generating becomes large, little direction of the camber of the substrate at the time of an injection is good, and it is [field granularity] good. [of the smaller one] For that purpose, the way of 100nm or less shaves crystal grain, there is little generating, and 100nm or less of surface roughness is desirable.
[0010] Furthermore, patterning is formed by a resist etc., a through hole etc. can be easily formed by etching a tantalum substrate, and wiring by which formed the tantalic acid-ized film upwards and patterning was carried out further can be formed.
[0011] Since etching of a tantalum can be performed by the dry etching which used CF4 and oxygen and the tantalic acid-ized film can be easily etched by the wet etching which used ammonium fluoride etc., the workability of a tantalum substrate is high.
[0012] On the other hand, the specific inductive capacity of tantalum oxide can also form the oxidation silicon film etc. on the tantalum oxide film, when a dielectric constant needs to be lowered as a whole, since it is high as compared with 4.5 of 28 and oxidation silicon. CVD (Chemical Vapor Deposition) by the oxidation pyrolysis of the silane (SiH_4) which heated oxidation silicon from 300 degrees C to 400 degrees C -- SOG (Spin On Glass) using law, polysilazane, etc. -- it can form by law etc.

[0013]
[Embodiment of the Invention] One example of this invention is explained below, referring to a drawing. Drawing 1 explains the structure of the cold cathode electronic instrument of this example, and drawing 2 (a) - (f) shows the tantalum substrate of drawing 1 , and the making process of the gate (control electrode).
[0014] In drawing 1 , the emitter wiring 12 and the emitter 13 which form cold cathode 11 on the emitter side glass substrate 10 are arranged. The emitter wiring 12 is formed in the shape of [of about 0.5 micrometer thickness] a stripe of a spatter etc. for example, in a molybdenum tantalum alloy. The number of stripes is decided according to the number of pixel Rhine. An emitter 13 fixes the carbon nanotube group arranged for example, in the shape of a field on emitter wiring with a silver paste etc., and is calcinated. The tantalum substrate 14 which consists of a tantalum plate with a thickness of 10 micrometers which has opening for letting the electron emitted as insulating support of the gate on it pass, and was covered by the autooxidation film is arranged. As shown in drawing 2 (d), the tantalum autooxidation film 24 covers tantalum plate 21 both sides, and is constituted, and the tantalum substrate 14 forms about 5 micrometers of oxidation silicon film 25 with the CVD method etc. on the tantalum autooxidation film in order to reduce the specific inductive capacity of the whole film further.
[0015] Furthermore, gate wiring which served as the gate 15 is formed in the top face. Patterning is carried out to the stripe so that 0.05 micrometers reaches, respectively, chromium, aluminum, etc. may carry out the laminating of the 1 micrometer to the gate 15 respectively, and may be formed in it by a spatter etc. and emitter wiring and a matrix may be formed. Opening of each gate is carried out corresponding to each opening 14a of the tantalum substrate 14.
[0016] Furthermore, cold cathode 11 is countered, the transparence electric conduction film (ITO) is formed in the anode side glass substrate 18 by a spatter etc. as an anode 16, on it, spreading desiccation is carried out and a fluorescent screen 19 is formed. For the insulation, the rib 17 with an anode 16 made with glass is arranged on the gate 15 between an anode 16 and the gate 15. A rib 17 corresponds to each pixel as vacuum support, insulating support, and blot prevention of fluorescence light, and fixed arrangement is carried out with frit glass etc.
[0017] Next, the anode side glass substrate 18 is stuck and set with the emitter side glass substrate 10 and a side windshield holder (not shown), by performing vacuum suction, it considers as the vacuum envelope 20 and a cold cathode electronic instrument is produced.
[0018] Manufacture of the tantalum substrate which turns into an insulating support substrate of the gate by drawing 2 is explained.
((a) Process) The tantalum plate 21 with a thickness of 10 micrometers is prepared.
((b) Process) In order to prepare opening 14a which it corresponds [a] to a pixel next and passes the emission electron, patterning is performed by the resist 23, and opening 14a of a tantalum plate is formed by dry etching. Dry etching is degree of vacuum 40pa, by the microwave plasma of 600W, makes the vacuum etching system which carried out 100sccm installation of 200sccm(s) and the oxygen for CF4 generate reactant gas constituents, and etches a tantalum into it.
((c) Process) It oxidizes thermally to the tantalum substrate 21 in which opening 14a was formed, and the tantalum autooxidation film 24 is formed. Autooxidation introduces oxygen and a steam in the electric furnace heated at 1000 degrees C, and about 3-micrometer tantalic acid-ized film 24 is formed also in a through hole by installing for 5 hours.
((d) Process) In order to lower the total dielectric constant of an insulator, the oxidation silicon film 25 is formed. The oxidation silicon film 25 is formed by carrying out 400sccm installation of 40sccm(s) and the oxygen for a silane, and installing a substrate for about 1 hour into the CVD system heated at 400 degrees C. Silicon nitride may be used instead of oxidation silicon.
((e) Process) The gate 15 by which patterning was carried out is formed on the tantalum substrate 14. For example, as a gate ingredient, chromium is formed in 50nm and aluminum is formed in the whole surface with 1000nm vacuum deposition method etc.
((f) Process) Subsequently patterning is carried out by the resist 27, and chromium and aluminum are etched. Chromium etching performs aluminum etching for example, using a nitric-acid 2 cerium ammonium water solution by being with phosphoric acid, a nitric acid, acetic-acid mixed liquor, etc.
[0019] The substrate produced as mentioned above was applied to the cold cathode electronic instrument (FED) of drawing 1 .
[0020] Since the conventional gate 35 shown in drawing 3 was formed on the glass rib etc. as a grid, its thickness of hundreds of micrometers or more was required for the glass rib on handling. The thickness part gate of glass and the distance between emitters were large.
[0021] In this invention, the thickness of a substrate is as thin as 10 micrometers, and it was supple, and since the gate and distance between emitters were sharply made small by making it function as a spacer, the effectiveness that it was low made or less in 1/5 with about 40V that the gate driver voltage of FED was conventionally required for more than 200V was acquired.
[0022] In addition, although thickness of a tantalum plate was set to 10 micrometers in this example, it can create from 5 micrometers or more, and conventional 100 micrometers can make it thinner compared with the glass which was a limitation.
[0023]
[Effect of the Invention] As explained above, this invention can do distance between the gate and an emitter small by using the tantalum substrate which has the autooxidation film for the insulation of the gate, and can offer FED of low driver voltage.

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CLAIMS

[Claim(s)]
[Claim 1] It is the cold-cathode electronic instrument characterized by coming to be supported with the tantalum substrate which consists of a tantalum plate with which said control electrode was covered by the autooxidation film in the cold cathode electronic instrument possessing the control electrode which is arranged in a vacuum envelope and this envelope, is prepared between the cold cathode which emits an electron, the anode which counters this cold cathode and is prepared, and said cold cathode and anode, and controls said electron.
[Claim 2] Said tantalum substrate is a cold cathode electronic instrument according to claim 1 which is arranged between said cold cathode and said control electrodes, and acts as a spacer.
[Claim 3] Said tantalum substrate is the cold cathode electronic instrument according to claim 1 characterized by thickness consisting of tantalum autooxidation film of 1 micrometer formed in both sides of the tantalum plate of 5 micrometers thru/or 50-micrometer thickness, and this tantalum plate thru/or 10-micrometer thickness.
[Claim 4] The cold cathode electronic instrument according to claim 1 or 3 characterized by having deposited the insulator layer of oxidation silicon or silicon nitride to both sides on a substrate at 1 micrometer thru/or 10-micrometer thickness in said tantalum substrate.
[Claim 5] The cold cathode electronic instrument according to claim 1 characterized by carrying out patterning of the wiring used as a control electrode, and having it on said substrate.

[Translation done.]